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Effect of Water Deprivation and Wool Coat Length on Body Fluid Compartments in Barki Sheep

M.H. Khalil

Department of Animal Production, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

TWENTY nine Barki ewes (Egyptian fat tailed breed) were used in this study. They were divided according to their wool length into 9 unshorn, 10 half-shorn and 10 shorn. Each of the three groups of sheep was divided into two subgroups : one was given water **ad libitum** and the other was deprived of water for a period of 120 hours in winter and 96 hours in summer. During the experimental period all ewes were kept under shade, the control group was separated from the water deprived animals and body fluid compartments were measured.

Sheep were able to withstand dehydration up to 19.5% loss in body weight without exhaustion. Also they rapidly rehydrated.

In both summer and winter, total body fluid and intracellular fluid volumes were significantly ($p < 0.01$) lower in the water deprived ewes than that of the control group. Significant ($p < 0.05$) higher extracellular fluid value was recorded in hydrated animals during the winter but not in the summer.

In both seasons, water deprivation did not cause any significant changes in blood volume, plasma volume and hematocrit values. Thus sheep can maintain relatively normal circulation during dehydration which is one of the most disturbed function in many mammals. Regulation of plasma volume is one of the main mechanisms underlying tolerance to dehydration.

Key words : Sheep, wool length, water deprivation, body fluids.

Survival of desert animals largely depends on their ability to use the available water efficiently. Patterns of body fluid distribution and the extent of maintenance of circulatory fluid volume at times of water stress are crucial factors for survival in the desert (Khan and Ghosh, 1985). Goat (Khan *et al.*, 1979) are known to maintain relatively constant circulatory volume under water stress conditions, however sheep and the donkeys apparently fail to maintain it (Khan, 1983).

Body fluid changes in sheep exposed to short-term water deprivation have been previously reported by Macfarlane *et al.* (1961) and Purohit *et al.* (1972). On the contrary, data on the effect of the interaction between wool coat and water deprivation on body fluid compartments are lacking. Accordingly, the present experiment was designed to study the effect of short-term water deprivation on body fluid compartments in sheep with different wool lengths during winter and summer seasons.

Material and Methods

The present experiments were conducted on 29 Barki ewes (a local fat tailed breed of Egypt), 3 - 3.5 years old with an average body weight of 29.64 ± 0.70 kg. The animals were maintained at an Experimental Station supervised by the Faculty of Agriculture, Al-Azhar University and located at El-Hammam, Matrough Governorate, Egypt. Before and during conducting these experiments all animals were kept under semi-open sheds day and night. They were fed on hay and concentrates according to their body weight requirements (Morrison, 1959). Water was provided *ad libitum* twice daily during the pre-experimental periods. All animals were healthy and clinically free from diseases.

The experimental animals were divided according to their wool length into 9 unshorn, 10 half-shorn and 10 shorn. The unshorn group had a mean wool length of 14.67 ± 1.07 cm and 11.95 ± 0.52 cm in summer and winter respectively and a mean fibre diameter of 27.77 ± 1.69 μm and 31.53 ± 1.15 μm in the same respective order. The half-shorn group had a mean wool length of 3.75 ± 0.19 cm and 2.70 ± 0.16 cm in summer and winter respectively and a mean fibre diameter of 32.51 ± 1.58 μm and 27.56 ± 0.73 μm in the same respective order. In this group shearing was performed about three months prior to the start of the experiments. In the shorn animals, shearing was carried out 25 days prior to the start of the experiments in order to avoid the effect of shearing on the measured parameters (Slee and Sykes, 1967 ; McNatty *et al.*, 1972).

Experiments were carried out in normal and water deprived ewes during both of the summer (August) and winte r (February), seasons.

In each experiment, each of the three groups was divided into two subgroups one was given *ad libitum* water and the other was deprived of water for 96 hours in summer and 120 hr in winter in order to collect all the blood samples involved in total body fluid determination. Animals were weighed at the beginning of the experiment and every 24 hours thereafter. The difference in body weights was used to calculate the percentage dehydration.

Blood samples for determination of body fluid compartments was first collected after 48 hours in summer and 72 hr in winter from the start of water deprivation.

Total body fluid volume (TBFV) was determined using tritiated water as described by Yousef *et al.* (1970). For each determination after a control blood sample was taken, a single dose of about 1.0 mc of tritiated water was injected in the right jugular vein. Blood was sampled from the left jugular vein after 12 hr and every 12 hr thereafter, for a period of 48 hours. The plasma samples were assayed for tritium by using Liquid Scintillation Spectrometer. Internal standard was used to correct for the quenching of color. Total body fluid volume was calculated as previously described by Aschbacker *et al.* (1965). The extracellular fluid volume (ECFV) was determined by the sodium thiocianate method as described by Yousef *et al.* (1970). The intracellular fluid (ICF) was calculated by subtraction of ECFV form TBFV. Hematocrit (Ht) was measured using a microhematocrit centrifuge according to Bauer (1970). The red blood cell volume (C.V.) was determined using ^{51}Cr. Knowing C.V., plasma volume (PV) and blood volume (BV) were calculated according to Yousef *et al.* (1970).

The length and diameter of wool fibres were measured during summer and winter seasons using wool samples that were taken from the right-mid-side position of the animals. Fibre length and diameter were measured according to the I.W.T.O. (1952 and 1961).

Ambient Temperature (Ta) (*i.e.* dry bulb temperature) and the percentage of relative humidity (RH) were measured by a thermohygrograph located about 1.5 meters from the ground.

Statistical analyses were carried out as described by Snedecor and Cochran (1973) and Ronald (1974).

Results and Discussion

Meteorological data during the experimental periods were obtained. In the winter season average minimum and maximum ambient temperatures were 8.75 ± 1.44 and 18.50 ± 0.58 °C respectively. Respective values for percent relative humidity were 37.50 ± 2.63 and 75.75 ± 1.65%. In the summer average minimum and maximum ambient temperatures were 18.40 ± 0.60 and 33.00 ± 0.97 °C respectively. Respective percent relative humidity were 30.71 ± 3.86 and 79.00 ± 2.32%. Accordingly, it is evident that the animals were exposed to heat stress during the summer season since the upper limit of the thermoneutral zone for sheep is about 24°C (Hahn, 1982). During the winter season, the shorn animals were probably exposed to cold stress at night (Khalil, 1980).

Body weight

The average body weights for all subgroups in both seasons are presented in Tables 1 and 2. There was no significant differences in body weight between the normal (control) and dehydrated groups in both seasons.

In winter, after 72 hr of water deprivation the percent body weight loss was 13.7%, 18.9% and 19.5% for the shorn, half-shorn and unshorn ewes respectively. Respective figures in the summer season, after 48 hr of water deprivation, were 12.4%, 12.2% and 11.3%. Several workers (More and Sahni, 1978 and Khalil *et al.*, 1985 & 1989) have reported similar loss in body weight during water deprivation in sheep. In the winter season, percent dehydration (% body weight loss) was greater as wool length increased. This result is perhaps due to the higher respiration rates (respiratory evaporation) in the unshorn ewes as they were under shade resulting in consequent greater loss in body fluid content (Khalil *et al.*, 1985).

Rehydration

Rehydration occured rapidly, where the dehydrated ewes drank enough to restore about 70.7% (in winter) and 90.5% (in summer) of the water loss within 3 - 7 minutes. All of the weight debit was repaid when food and water were given *ad libitum* within 36 hr in both seasons. Overhydration was never observed.

The data presented above establish the remarkable ability of sheep to withstand dehydration up to 19.5% without exhaustion. Additionaly, the rapidly of rehydration is equally striking. These physiological adaptations have been found in the Ossimi, Rahmani and their crosses with Finish Landrace (Khalil *et al.,* 1989). The notable tolerance to high level of dehydration may explained by the ability of the animals to regulate their plasma volume as discussed thereafter.

Body fluid compartments

The mean values for the various body fluid compartments in all subgroups are presented in Table (1) (winter season) and Table (2) (summer season). Single way analysis of variance and Duncans' Multile Range Test revealed that in both seasons, the wool coat had a non-significant effect on body fluid compartments.

As an overall mean, " t-test " indicated that in both seasons (TBFV) and (ICFV) were significantly ($p < 0.01$) lower in the water deprived ewes than that of the control. Significant ($p < 0.05$) higher ECFV value was measured in sheep given water compared to the water deprived group in winter.

Water deprivation did not cause any significant decrease in BV, PV and Ht in both summer and winter seasons.

The data, indicate that, during water deprivation body water was lost chiefly from the ICFV followed by ECFV (Tables 1 & 2). In other words, the greatest contribution to the total body water loss was from ICFV and ECFV, whereas, the smallest relative loss was from PV and BV (Tables 1 & 2). Thus, dehydrated sheep seems to be able to maintain relatively normal circulation which is one of the most disturbed functions in many mammals. This finding supports previously published work using sheep (More and Sahni, 1978 and More and Rawat, 1984) ; sheep and goats (El-Hadi, 1986) and burro or donkeys (Yousef *et al.,* 1970). What maintains plasma volume relatively constant as compared to other body fluid

TABLE 1. Means ± standard errors of body weight (BW), total body fluid volume (TBFV), extracellular fluid volume (ECFV), intracellular fluid volume (ICFV), blood volume (BV) and plasma volume (PV) of normal and 72 hours water deprived shorn, half shorn and unshorn ewes in winter season.

	Normal (control group)				Water deprived group			
	Shorn	Half-shorn	Unshorn	$\bar{X}_1$ over all	Shorn	Half-shorn	Unshorn	$\bar{X}_2$ over all
BW (zero time)	26.00 ± 2.00	33.25 ± 3.35	26.00 ± 4.24	28.45 ± 2.15	28.00 ± 1.53	31.00 ± 1.96	30.75 ± 1.65	30.09 ± 1.00
BW (after 72 hr) water deprivation	28.75 ± 2.77	31.88 ± 3.50	25.00 ± 2.70	28.54 ± 1.79	24.17 ± 2.33	25.13 ± 2.30	24.75 ± 1.13	24.73 ± 1.01
TBF (liter)	17.92 ± 2.84	20.91 ± 0.95	16.74 ± 2.31	18.58 ± 1.21	15.89 ± 1.74	11.97 ± 2.61	13.02 ± 1.35	13.42 ± 1.17
TBF (liter/kg BW)	0.70 ± 0.07	0.64 ± 0.04	0.65 ± 0.02	0.66 ± 0.02 **	0.57 ± 0.05	0.38 ± 0.07	0.43 ± 0.07	0.45 ± 0.04 **
ECF (liter)	9.95 ± 0.77	8.48 ± 1.44	9.05 ± 0.55	9.06 ± 0.63	9.29 ± 0.64	7.50 ± 2.08	6.99 ± 0.83	7.93 ± 0.75
ECF (liter/kg BW)	0.38 ± 0.01	0.28 ± 0.05	0.44 ± 0.31	0.36 ± 0.03 *	0.32 ± 0.00	0.23 ± 0.03	0.24 ± 0.00	0.26 ± 0.02 *
ICF (liter)	9.62 ± 3.24	11.72 ± 0.73	4.89 ± 1.72	9.17 ± 1.44	8.32 ± 0.25	3.53 ± 1.23	8.26 ± 1.69	6.71 ± 1.14
ICF (liter/kg BW)	0.38 ± 0.12	0.37 ± 0.04	0.23 ± 0.05	0.33 ± 0.04 **	0.29 ± 0.03	0.11 ± 0.02	0.29 ± 0.09	0.23 ± 0.05 **
BV (liter)	0.78 ± 0.04	0.92 ± 0.08	0.58 ± 0.08	0.81 ± 0.04	0.80 ± 0.12	0.64 ± 0.10	0.80 ± 0.07	0.73 ± 0.06
BV (liter/kg BW)	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.01	0.02 ± 0.00	0.03 ± 0.00	0.02 ± 0.00
PV (liter)	0.57 ± 0.02	0.71 ± 0.06	0.58 ± 0.06	0.62 ± 0.03	0.60 ± 0.09	0.53 ± 0.11	0.62 ± 0.07	0.58 ± 0.05
PV (liter/kg BW)	0.02 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00
Ht %	24.25 ± 1.25	22.75 ± 0.85	24.50 ± 1.19	23.83 ± 0.63	24.50 ± 0.50	24.50 ± 0.65	22.50 ± 1.19	23.70 ± 0.60

* = Significant ($p < 0.05$) difference between X_1 and X_2

** = Significant ($p < 0.01$) different between X_1 and X_2

kg = kilogram.

TABLE 2. Means ± standard errors of body weight (BW), total body fluid volume (TBFV), extracellular fluid volume (ECFV), intracellular fluid volume (ICFV), blood volume (BV) and plasma volume (PV) of normal and 48 hours water shorn, half shorn and unshorn ewes in summer season.

	Normal (control) group				Water deprived group			
	Shorn	Half-shorn	Unshorn	$\bar{X}_1$ over all	Shorn	Half-shorn	Unshorn	$\bar{X}_2$ over all
BW (zero time)	28.75 ± 2.59	26.60 ± 1.33	28.50 ± 1.44	27.85 ± 0.99	29.25 ± 1.03	27.80 ± 2.06	30.88 ± 2.44	29.19 ± 1.10
BW (after 48 hr) water deprivation	28.50 ± 2.25	26.10 ± 1.29	28.00 ± 1.68	27.42 ± 0.96	25.63 ± 0.94	24.40 ± 1.83	27.38 ± 1.60	25.69 ± 0.91
TBF (liter)	24.95 ± 3.50	22.75 ± 1.38	23.50 ± 1.74	23.66 ± 1.27	20.07 ± 0.82	19.74 ± 1.18	22.36 ± 1.89	20.65 ± 0.78
TBF (liter/kg BW)	0.86 ± 0.04	0.84 ± 0.02	0.82 ± 0.03	0.85 ± 0.02 **	0.69 ± 0.03	0.72 ± 0.03	0.73 ± 0.02	0.71 ± 0.02 **
ECF (liter)	7.66 ± 0.70	7.70 ± 0.70	7.18 ± 0.68	7.53 ± 0.43	7.90 ± 0.32	7.07 ± 0.61	6.24 ± 1.10	7.07 ± 0.41
ECF (liter/kg BW)	0.27 ± 0.04	0.29 ± 0.03	0.25 ± 0.02	0.27 ± 0.02	0.27 ± 0.02	0.26 ± 0.03	0.20 ± 0.03	0.25 ± 0.02
ICF (liter)	17.30 ± 3.42	15.06 ± 1.50	15.79 ± 0.83	15.99 ± 1.24	12.17 ± 0.80	12.67 ± 1.14	16.12 ± 1.21	12.47 ± 1.22
ICF (liter/kg BW)	0.58 ± 0.06	0.56 ± 0.04	0.56 ± 0.04	0.57 ± 0.03 **	0.42 ± 0.02	0.46 ± 0.03	0.52 ± 0.01	0.46 ± 0.02
BV (liter)	1.26 ± 0.20	1.53 ± 0.13	1.37 ± 0.16	1.39 ± 0.09	1.11 ± 0.05	1.26 ± 0.21	1.16 ± 0.08	1.18 ± 0.09
BV (liter/kg BW)	0.05 ± 0.01	0.06 ± 0.01	0.05 ± 0.01	0.05 ± 0.04	0.04 ± 0.00	0.05 ± 0.01	0.03 ± 0.00	0.04 ± 0.01
PV (liter)	0.93 ± 0.15	1.15 ± 0.11	1.10 ± 0.12	1.06 ± 0.07	0.84 ± 0.04	0.98 ± 0.17	0.88 ± 0.07	0.90 ± 0.07
PV (liter/kg BW)	0.03 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.03 ± 0.00	0.04 ± 0.01	0.02 ± 0.01	0.03 ± 0.00
Ht %	26.50 ± 1.25	24.00 ± 1.52	19.50 ± 0.87	23.38 ± 1.06	23.75 ± 0.25	23.60 ± 0.93	23.75 ± 1.93	23.69 ± 0.63

** = Significant ($p < 0.01$) difference between X_1 and X_2

kg = kilogram

compartments is not known. Further, studies on capillary wall permeability and movement of protein fractions, specifically albumin reveal the underlying mechanisms.

Water deprivation in winter and summer did not cause any change in Ht % (Tables 1 & 2). This result agrees with those obtained by More and Sahni (1978).

In conclusion, the sheep tolerance to dehydration may depend, at least in part, on their ability to maintain normal blood volume. This helps to maintain circulation and thus heat dissipation.

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أثر التعطيش وطول الغطاء الصوفى على توزيع سوائل الجسم فى اغنام البرقى

مدحت حسين خليل محمد

قسم الانتاج الحيوانى - كلية الزراعة - جامعة الازهر - مدينة نصر - القاهرة .

اجريت هذه الدراسة على عدد ٢٩ نعجـــة من اغنـــام البرقى المحلية قسمت النعاج حسب طول الغطاء الصوفى الى تسعة نعاج غير مجزوزة وعشرة نعاج عليها غطاء صوفى نمو ثلاثة اشهر وعشرة نعاج مجزوزة . ثم قسمت كل مجموعة من الثلاثة مجموعات السابقة الى تحت مجموعتين احداها ترك أمامهـا الماء تشرب بحريتها والاخرى منع عنها الماء لمدة ١٢٠ ساعة فى الشتاء و ٩٦ ساعة فى الصيف .

اثناء فترة التجربة كانت كل النعاج موضوعة تحت الظل مع فصـــل مجموعة النعاج التى تشرب عن المجموعة المعطشة .

أظهرت النتائج المقدره الفائقة للاغنام على مقاومة العطش حتى فقدت ١٩٫٥٪ من وزنها بدون ان يحدث اى مضاعفات أو تعب .

كما اظهرت مقدرة عجيبة ايضا عند شربها لكميات كبيرة من الماء بعد فترات التعطيش .

حدث فى كل من الصيف والشتاء انخفاض عالى المعنوية فى المجموعة المعطشة بالمقارنة بالمجموعة المقارنة فى كل من سوائل الجســـم الكلية والسوائل داخل الخلوية اما السوائل خارج الخلوية فقد حدث بهـــا انخفاض معنوى فى موسم الشتاء فقط .

فى كلا الموسمين لم يؤد التعطيش الى نقص معنوى من حجم الدم اوحجم بلازما الدم اوالنسبة المئوية لكرات الدم الحمراء فى البلازما (الهيماتوكريت) وبالتالى فان الاغنام يمكنها تنظيم دورتها الدموية اثناء التعطيش والذى يعتبر من اهم العوامل التى تســـبب قدرتها على مقـــاومة العطش .